

NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report

April 1957

GENERAL

We (that is the Watershed Management Research staff at Upper Darby, all one of us) spent most of the last 6 months programming. Programwise, to coin a term, we found ourselves in the following situations:

1. Working with Supervisor E. M. Bacon and staff assistant Paul Sundheimer setting up snow surveys in the Allegheny National Forest --aided no end by a spare snow tube and scale that Chuck Wellner from Intermountain sent us.
2. Flying over the Potomac River Basin with Al Snow and Pete Bond (Asst. State Forester of Maryland) looking for experimental watersheds.
3. Locating a weir site for a cooperative research program with Pennsylvania State College and the Pennsylvania Department of Forests and Waters.
4. Inspecting the Kingston and White Pine-Hardwood Centers (I barely passed).
5. Walking the Fernow's proposed road system on the watersheds and listening to Sid Weitzman extol the ivy-clad environs of the Lake State Station.

Meanwhile, back at the Centers:

KINGSTON RESEARCH CENTER

New Studies

Following the completion and review of the Kingston watershed management problem analysis, a conference was called on October 11 in Harrisburg, Pa. to discuss possible studies that might be initiated in the Kingston Research Center area. Those attending were: Secretary Maurice Goddard, Joe Ibberson, Clyde Pyle and Gene McNamara from the Pennsylvania Department of Forests and Waters; Dr. Bill Bramble, Dave Worley, and Dick Byrnes from the School of Forestry, The Pennsylvania State University; and Marquis, Lull, and Reigner from the Northeastern Forest Experiment Station. After a short discussion, a three-way cooperative project was developed for watershed studies in the State

College area. A series of watersheds will be gaged to determine the effects of forest management practices in oak forests on water yield and quality.

The oak type, which covers more area than any other type in Pennsylvania, has been neglected in watershed studies. The State, with its increasing water problems, requires information on management practices. The State College area is ideal for the project, lying within the oak type and with large areas of University Forest and State Forest lands on which to locate watersheds. In addition, the Forestry School is eager to help set up the watershed studies for use as an outdoor laboratory in student training.

Since the original conference, Reigner, McNamara, Worley and Byrnes have combed the area for good watershed areas. It was finally decided to accept a series of watersheds examined during the first visit. They are predominantly sandstone but each has a low shale hill near its weir site.

Most of one week in March was spent at Penn State picking out the weir location for the first watershed and creating a suitable weir design. Ken Reinhart, of the Mountain State Center, attended the conferences along with Worley, Byrnes, McNamara and Reigner.

The weir design finally agreed upon is rather unconventional. The streambanks are low and the gradient is gentle at the weir site, thus eliminating the classic V-notch weir which requires a deep pool. A low control such as the Trenton-type would not give the desired sensitivity at low flows. The tentative design calls for a sharp-crested notch consisting of a 90-degree V at the bottom, grading into a 120-degree for the second foot. The notch will be set low in the control. Above the notch, higher flows will be measured on a one-to-ten slope across a broad crested section. A rating curve will be developed by periodic current metering. The design will be essentially similar to the Columbus Deep-Notch, but should be easier to construct and maintain.

Watershed Calibration

The Dilldown Watershed calibration analysis has been continued. Working for monthly streamflow estimates we investigated and refined the weighting system to be applied to antecedent rainfall in the estimation of total watershed storage. Originally, we had used a straight-line recession as a basis for figuring weighted antecedent moisture conditions. Next a reciprocal recession was used with improved results. The reciprocal in this case was $1000/9 + \text{number days}$. Thus, the immediately preceding day was given a weight of $1000/9 + 1 = 100$; the second day $1000/9 + 2 = 91$, etc. We tested the weighting system by including two independent variables, the precipitation for the immediately preceding day and the precipitation for the second preceding day. Both were significant and showed the weight for the first day too high and that for the next day was too low. As this indicated the reciprocal slope was

too steep, we next tried a logarithmic recession, as suggested by Linsley, Kohler, and Paulhus. The difference between the two systems was negligible, but the latter is a much more describable value.

Extending antecedent values into the past, we found improvement in the storage relationship up to 80 days. Beyond this point, weighting becomes very small and calculations increasingly tedious. The logarithmic recession for this period begins at 100 and ends at 4.

After arriving at a tentative end point in monthly streamflow estimates we applied the same parameters to seasonal estimates. Results were discouraging until we dug into the problem; then several new relationships appeared.

We discovered that antecedent effects of precipitation vary between the seasons. In winter, when storage levels are high, antecedent effects past 40 days are unimportant. But in the warm months, when storage values may be low, antecedent effects back to 80 days are important. Furthermore, we found that antecedent rainfall may be weighted on a straight line basis. Thus, for a 40-day antecedent period, rainfall on the last day is given a weight of 40, while rainfall on the first day of the period is given a weight of 1. In the 80-day period, the last day is given a weight of 80. This relationship has been well tested. The straight line weighting systems result in higher correlations than the logarithmic system; also the weighting period for the spring and fall months turned out to be 60 days.

Another improved relationship is the use of sums of daily temperatures rather than an exponential form of mean monthly temperature. First, we summed temperatures over 50°F, as suggested by the Russian, Budyko. The sums of the daily maximum temperatures over 50° are highly correlated with the mean monthly temperatures to the fourth power. We like the summation as it is more logical and easier to explain.

Completing seasonal analyses, we used the new parameters in the year-long monthly analysis. Variable antecedent effects were valid, but the temperature factor was found to be curvilinear. Further investigation showed that the summation of maximum and minimum temperatures over 30 degrees should be used. A better expression of evaporation capacity would be the summation of hourly temperatures over the base temperature.

As usual, there is a lag in temperature. The temperature for the previous month is averaged with the temperature for the last month of the period on a 35-65 ratio. The new parameters have given the best estimate of monthly runoff to date.

Scrub Oak Conversion

The root rake site preparation was completed at the end of November; 245 acres were treated. Planting is proceeding at a fast clip even though the weather has been even less cooperative than usual. First we had warm weather which allowed the nurseries to dig and ship trees before we had anticipated, then after the trees arrived, we were besieged by snow and heavy rain. Groundwater is now at a high level--it was rather low 10 days ago--and many of the root raked strips are under water.

Meetings

Reigner attended the Allegheny Section meeting at Baltimore in February.

MOUNTAIN STATE RESEARCH CENTER

Caging was started November 1, 1956 on Watersheds No. 6 and No. 7. Cutoff walls for the weirs were constructed about a year ago. One recording and 5 standard rain gages were put in operation. These two watersheds, each about 60 acres in size, will be used after calibration to separate out the effects of road-building practices from timber-cutting practices.

Our primitive soils lab was decimated last fall when we had to return a drying oven and Toledo scales which were on loan. After many delays, we were able to replace these items and to install a hot water heater and a new sink. Though still a modest setup, we are now in pretty good shape.

During the quarter, considerable progress was made in separating out the stone from soil samples collected last summer. We are using a wet-sieving technique. The lab is looking less and less like a dirt-storage warehouse.

We have obtained a Nuclear Moisture Meter designed by Dr. van Bavel and others and manufactured by William B. Johnson and Associates. Plans have been developed for testing the outfit and preliminary tests have been made. The instrument measures moisture content on a volume basis, thus presenting the opportunity to determine amount of water present without determining soil bulk density or stone content. We are having trouble getting the instrument to work properly; we hope that with Dr. van Bavel's help we can get it to live up to advance billing.

We have had considerable discussion of possible ways to improve muddy streamflow by settling out or filtering out sediments. Our interest is sparked by the need to minimize the effect of our "poor practice" watersheds on the stream leaving the experimental area. Trials will be made to see what we can come up with. Helpful suggestions from any source will be appreciated. A chute has been built for testing methods; we're groping our way forward slowly in this field.

Analysis of data from 5 years of record on watersheds 1 through 5 was completed. A session was held on the Fernow Forest from March 25 to 29 to review plans for treating the gaged watersheds. The experts Director Marquis, Lane, Lull from Upper Darby, Weitzman from St. Paul, and Trimble from Laconia, along with local personnel, worked over the problems from top to bottom. A sound basis for going ahead should result.

Reinhart prepared a paper Calibration of five small forested watersheds for delivery April 30 at the AGU meeting in Washington, D. C.

Reinhart attended planning session at Penn State to consider weir construction and other problems in proposed cooperative research between Penn State, Pennsylvania Department of Forests and Waters, and the Northeastern Forest Experiment Station.

WHITE PINE-HARDWOOD RESEARCH CENTER

Problem Analysis and Working Plans

A problem analysis for watershed management research in the White Mountain area has been completed and submitted to the Director.

The following working plans have been prepared:

"Installation and operations of snow and frost stations on gaged watersheds."

"For a study of treatment effects on humus conditions on gaged watersheds."

"For evaluating the effects of watershed treatments on sediment discharge from gaged watersheds." Proposes measurement of both suspended sediment and bedload.

"For skid road seeding studies on the Hubbard Brook Experimental Forest." Proposes further studies based on the results of seedings made at Bartlett in 1955 and 1956. The following mixtures will be tested on triplicated plots:

1. Red top - 10 lbs.; creeping red fescue - 10 lbs.; bird's foot trefoil - 10 lbs.; orchard grass - 10 lbs.
2. Red top - 20 lbs.; orchard grass - 15 lbs.
3. Red top - 20 lbs.; creeping red fescue - 15 lbs.
4. Red top - 15 lbs.; creeping red fescue - 15 lbs.; bird's foot trefoil - 10 lbs.
5. Red top - 20 lbs; alta fescue - 15 lbs.

These mixtures will be seeded with the following amounts of lime and fertilizer on a per mile of road basis (equal to approximately 1 acre):

1. 600 lbs. 10-10-10 fertilizer and 1 ton lime.
2. 600 lbs. 10-10-10 fertilizer and $\frac{1}{2}$ ton lime.
3. 600 lbs. 10-10-10 fertilizer and no lime.
4. 300 lbs. 10-10-10 fertilizer and 1 ton lime.
5. 300 lbs. 10-10-10 fertilizer and $\frac{1}{2}$ ton lime.
6. 300 lbs. 10-10-10 fertilizer and no lime.
7. No fertilizer and 1 ton lime.

A manuscript on seeding results to date is being prepared for publication.

An agreement has been made with Duke University for a cooperative study of White Mountain landslides and their revegetation. Ed Flaccus, a New Hampshire man who is working toward a Ph. D. in Ecology at Duke, is making the study. Ed has already mapped on USGS quadrangle sheets most of the existing slides. From this study we hope to get at least partial answers to most of the following:

- (1) The magnitude and nature of the problem involved as it concerns water supplies--both actual and potential.
- (2) The causes of these slides--if possible.
- (3) Identifiable conditions to be found in areas where slides are likely to occur so that this can be considered before designating municipal watersheds.
- (4) Any leads as to the need for designed research, and if needed, what type.
- (5) The pattern of slide revegetation.

Studies Initiated

A study is underway to determine if the color of tree bark has an effect on the rate of snowmelt around the trunks. A number of beech trees were chosen for the study; one-third were painted white to a height of about 6 feet; one-third were painted black; and one-third were left unpainted. The width of melt rings will be measured at the four cardinal directions and co-variance analysis will be used to eliminate the effect of tree diameter. Due to the scant snow cover it may not be possible to complete the study this year.

A study to determine the effect of soil freezing on infiltration rate has been started. Ring infiltrometer runs are being made on frozen and unfrozen ground in forest and open cover. "Concrete" and "granular" types of freezing are being tested. If the condition termed "honeycomb" frost can be found it will be tested. Data collected to date indicate that concrete frost under open land conditions is impervious, but under woodland conditions may in places permit infiltration through root holes, worm holes, or burrows.

Office Reports

Three office reports on current work have been recently completed and submitted to the Director:

"On seeding logging roads in New Hampshire to prevent erosion" by John C. Bjorkbom and George R. Trimble, Jr.

"On the reconnaissance soil survey of the Hubbard Brook Experimental Forest" by Robert S. Pierce. Based partly on this work a paper has been prepared for publication and is in the final stages of

review (we hope): "A soil survey for forest land: A method developed for use in rough mountain land in the northeast", by Lloyd Garland (SCS), Robert S. Pierce, and George R. Trimble, Jr.

"On design and construction of gaging Station No. 2" by Robert S. Pierce. Replete with photos and diagrams this paper describes details of construction of a V-notch weir and gage house suitable for gaging small streams in the White Mountains.

Hubbard Brook Experimental Forest

Weir #2, a 120° , 2-foot V-notch installation, went into operation at the beginning of the dormant season--October 16. Weir #1 has now been in operation over a year. We made a volumetric calibration on weir #1 this past summer. Bob Pierce, who master-minded the construction job this summer, is completing a report covering our weir building experiences to date.

Ray Lavigne, who has been in residence at the Experimental Forest for 9 months now, has been busy on office computations of past rainfall and runoff records as well as collecting current data. We are now operating 2 weirs, 1 weather station, 2 recording rain gages, 4 standard rain gages, and 4 snow and frost stations where numerous observations are made on snow conditions (depth and snow water content) and on soil freezing. Bob Pierce teams up with him every Monday for a ski and snowshoe circuit covering all the watershed installations.

Construction of the permanent road into the Hubbard Brook Experimental Forest began in October. This first section of road will be about two miles long. When the contractor stopped work late in December because of heavy snow and subzero weather, about half the job had been done. We estimate he will finish up in early June unless a late melt period delays him in getting started again next spring. We hope that bids will be let early next summer for a second section of road.

Consideration is being given to making nuclear waste disposal tests on the Hubbard Brook Experimental Forest. The effect of this material on soil and water will be a big problem when the atomic energy plants now envisioned for New England are an actuality. Howard Lull has made some preliminary contacts. An on-the-ground meeting is planned for June with Dr. Thomas of Harvard and Dr. Joe Lieberman of the AEC.

We have received a portion of the 10-foot contour map of the Hubbard Brook Experimental Forest which is being prepared in Washington by the Engineering Division of the USFS from aerial photos.

Meetings

February 7-8--Sartz attended the annual meeting of the Eastern Snow Conference in Syracuse, N. Y. He presented a paper entitled "Snow and frost measurements in a watershed management research program". This will be published as a Station Paper.

March 7-8--Trimble attended the SAF meeting (New England Section) in Boston.

Miscellaneous

A large group of Soil Conservation Service Soil Scientists employed throughout New England made a tour of the Hubbard Brook Experimental Forest in October.....Sartz, Pierce, Lavigne, and Trimble attended a course in concrete-making given in Laconia by the Portland Cement people.

PUBLICATIONS

The role of forest humus in watershed management in New England.
G. R. Trimble, Jr. and Howard W. Lull. Northeastern Forest Exp. Sta.
Paper 85, 34 pp., illus. 1956.

Factors influencing streamflow from two watersheds in northeastern Pennsylvania. Howard W. Lull and Herbert C. Storey. Jour. Forestry 55: 198-200. 1957.

Water yields from small forested watersheds. Sidney Weitzman and Kenneth G. Reinhart. Jour. Soil and Water Conserv. 12: 56-59. 1957.

New Hampshire guides for logging roads and skid trails. G. R. Trimble, K. E. Barracough, T. F. Breon, and L. B. Sargent. Extension folder 35, Univ. of New Hampshire, 4 pp., illus. 1957.

Manuscripts submitted

Soil compaction on forest and range lands. Howard W. Lull.

Forest soil-moisture relations in the coastal plain sands of southern New Jersey. Howard W. Lull and John H. Axley.

How far from a stream should a logging road be located? G. R. Trimble, Jr. and R. S. Sartz.

Snow and frost measurements in a watershed management research program. R. S. Sartz.

Forests guard the Potomac. Howard W. Lull and Ralph W. Marquis.